

# pH Sensor and pH Control Development and Evaluation

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Successful operation of bioreactors depends in part on the monitoring and control of pH in culture fluids. The demands on sensor performance are particularly stringent in NASA space bioreactors used on the Space Shuttle and Space Station. In short-term Space Shuttle missions, automated sensor technology is particularly critical to minimizing valuable crew time; therefore, we developed and tested a reliable optical-based pH sensor in perfused vessel bioreactors.

The pH sensor measures the light absorption characteristics of phenol red present in the culture medium, and the ratio of the transmitted green to red light intensity is correlated to the pH of the solution. The measurement is accurate within  $\pm 0.1$  pH unit in the pH range between 6.5 and 7.5. The bioreactor is used to culture adherent mammalian cells. The calibration of the pH sensor remained constant during the 120-day cell run.

The pH control system consists of an optical pH sensor, a buffer, and the necessary hardware and LabView software to run the system. The pH sensor measures the pH of the perfused culture medium in the bioreactor where mammalian cells are grown. A buffer, consisting of a mixture of sodium and potassium hydroxide and bicarbonate, was added to the perfused

culture medium to keep the pH within a known range. The volume of the buffer needed for a 0.1-pH change varies, depending on the desired pH range needed for the respective cell culture and the medium solution.

In the figure, in the first two cycles of

titration we infused fresh medium every two hours, and in the second two cycles of titration we infused fresh medium every four hours. The pH of the medium during these periods was maintained within a pH of 7.0 and 7.1.

